ESHMC Training – Tools for Simulating Curtailment with ESPAM2.0

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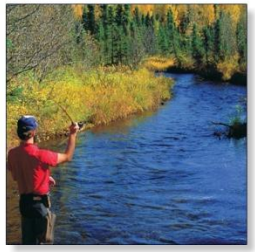
June 15, 2012

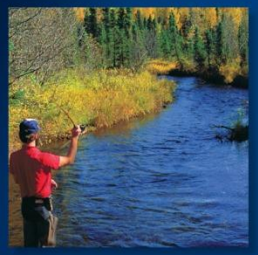
OVERVIEW

- Curtailment IAR Tool
  - Calculates junior irrigated land area by model cell and groundwater irrigation entity
  - Writes IAR file
- MKMOD
  - Calculates crop irrigation requirement by model cell and groundwater irrigation entity
  - Writes well file and summary table
- MODFLOW
  - Calculates response to applied stress
  - Writes binary head and water budget files
- BUD2SMP
  - Processes binary water budget file

GETTING STARTED

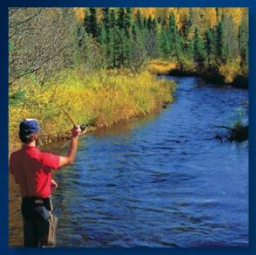


- Install required software
- Download input files
- Links provided in handout

CURTAILMENT IAR TOOL INPUT DATA

- 2012 POD file (or most current)
  - Provides data used to calculate junior priority fraction by model cell
  - Locations of groundwater PODs from IDWR water right database
  - Water right priority date
    - Adjusted to subordinate date for enlargements
  - Irrigation diversion rate
    - Water right rate divided by number of PODs

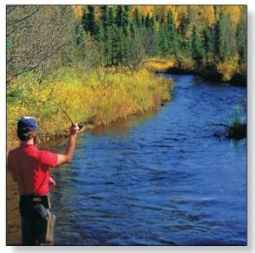
CURTAILMENT IAR TOOL INPUT DATA

- 2008 Irrigated Lands Raster (or most current)
- Average Groundwater Fraction Raster
- Wetlands/Urban Mask
- Groundwater Entity Raster
- Surface Water Entity Raster

CURTAILMENT IAR PROCESSING STEPS

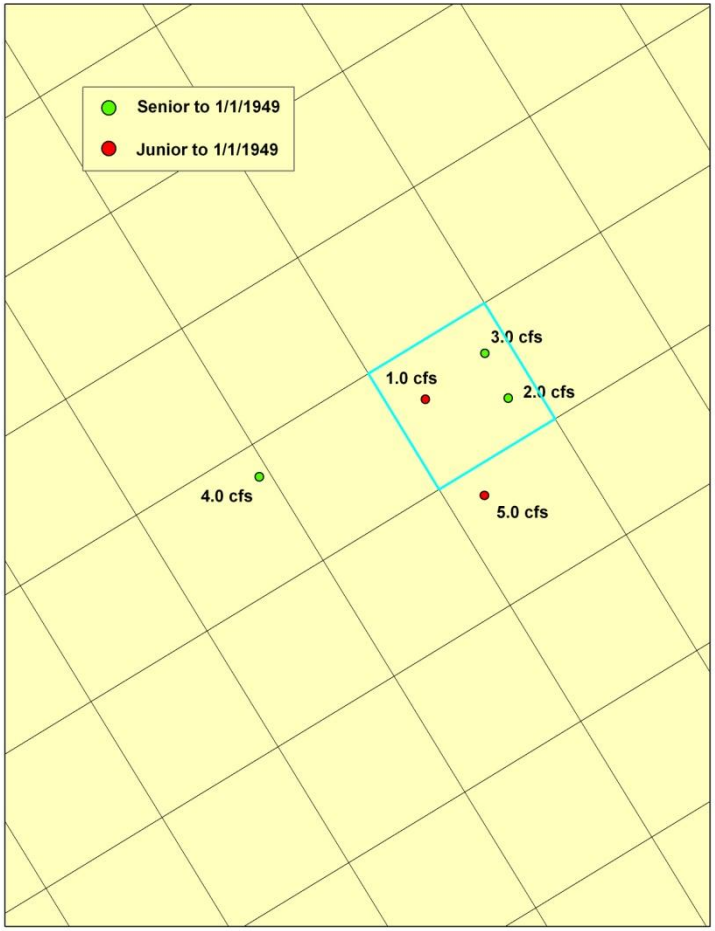
- Calculate junior priority fraction by model cell
  - Uses same algorithm as pdate.exe from ESPAM1.1 tools
  - Basis: Junior CFS/Total CFS ~ Junior CU/Total CU
    - Tested by IWRRI (2004)
    - http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/meetings/2012_ESHMC/04_16_2012/VB_P_DIV_FRAC.zip

CURTAILMENT IAR PROCESSING STEPS

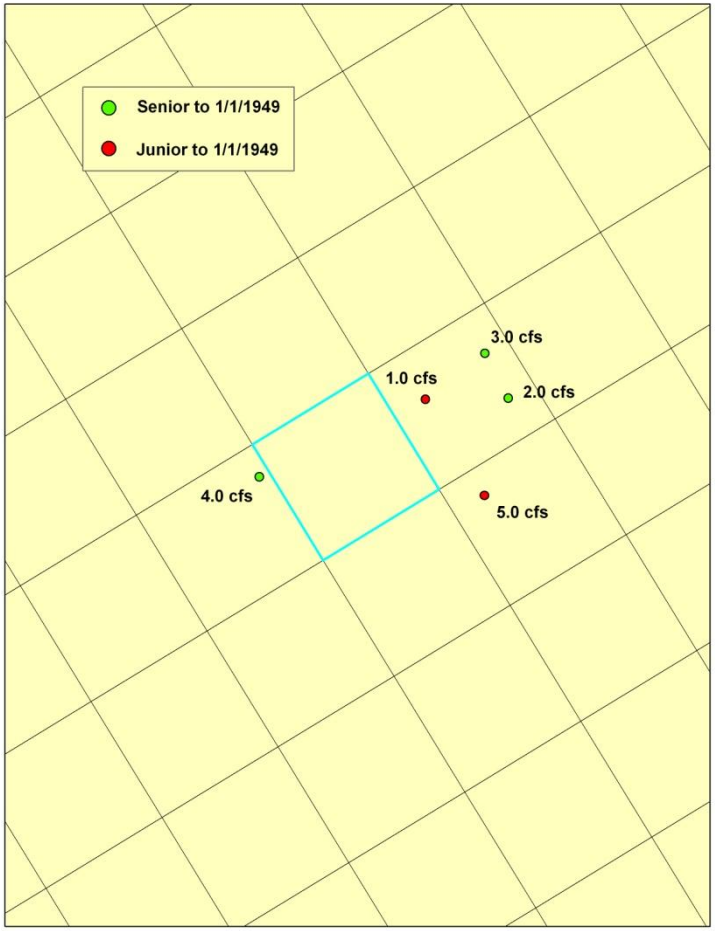
- Calculate junior priority fraction by model cell
  - Read user-specified priority date
  - Calculate POD diversion rate by model cell
  - Calculate POD diversion rate junior to user-specified date by model cell
  - If a cell has no PODs, it is assigned the junior fraction calculated from the eight adjacent cells
  - If none of the eight adjacent cells have PODs, the cell is assigned to global junior fraction
  - If cell is in Mud Lake or Monteview place of use, junior fraction is calculated based on PODs in well field and place of use cells

CURTAILMENT IAR PROCESSING STEPS



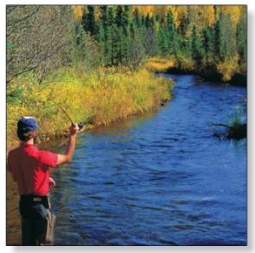
- Example – cell with PODs
- Cell irrcfs = 1+2+3 = 6
- Junior irrcfs = 1
- Junior fraction = 1/6 = 0.16667

CURTAILMENT IAR PROCESSING STEPS



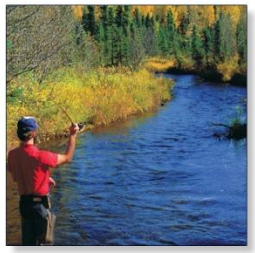
- Example – cell without PODs
- Adjacent cells irrcfs = 4+1+2+3+5 = 15
- Junior irrcfs = 1+5 = 6
- Junior fraction = 6/15 = 0.40

CURTAILMENT IAR PROCESSING STEPS

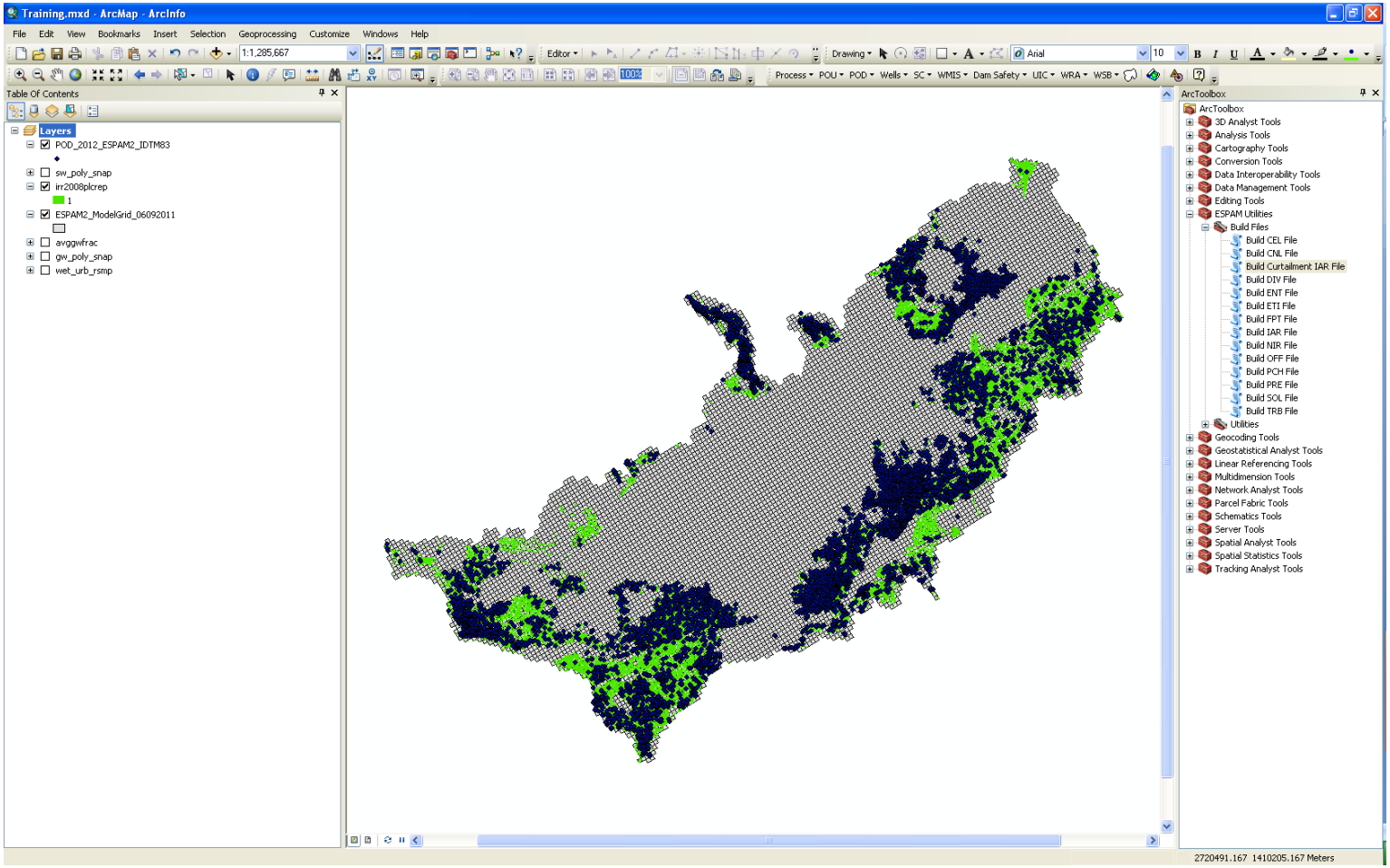
- Calculate groundwater irrigated lands by model cell and irrigation entity
  - Same process as IAR Tool used to calculate irrigated area for calibration
  - Remove wetlands and urban areas from irrigated lands
  - Apply groundwater source fraction to determine groundwater irrigated lands
  - Assign irrigated lands to model cell and irrigation entity (IEGW500, IEGW501, etc.)

CURTAILMENT IAR PROCESSING STEPS



- Apply user specified multipliers to irrigated lands
  - Multiply groundwater irrigated lands by -1 to model injection
  - Multiply surface water irrigated lands by zero to remove from data set
- Apply junior priority fraction to groundwater irrigated lands

RUNNING CURTAILMENT IAR TOOL FROM ARC TOOLBOX



RUNNING CURTAILMENT IAR TOOL FROM COMMAND LINE

- Syntax: espamtool -t curtailment -o <Output IAR File> --sp=<Number of Stress Periods> -r <Output Raster Directory> -p <Priority Date in MM-DD-YYYY> --est-flag <A|G> --gw-multiplier=<Ground Water Multiplier> --sw-multiplier=<Surface Water Multiplier>
- Example: espamtool -t curtailment -o D:\ESPAM2\TEST\out.iar -r D:\ESPAM2\TEST --sp=1 -p 1-1-1949 --est-flag=A --gw-multiplier=-1 --sw-multiplier=0

LUNCH BREAK

BASE FILES FOR MKMOD

- MKMOD requires all 16 input files
- NULL_BASE file set has all recharge components set to zero
- ET and precipitation by model cells are 10-year average for November 1998 – October 2008
- Replace one input file to simulate response to a single component of recharge in superposition mode
- Example: Replace IAR file with output from Curtailment IAR Tool to simulate response to curtailment

MDL FILE FOR STEADY STATE SIMULATIONS

Null.mdl file is designed for use in steady state simulations with **average annual values** in Null.ETI and Null.PRE files.
Adjustment factors for NIR and wetlands are from calibration run E120116A008.

```
DAYS
FEET
1 1 1
365.25   SS
104
209
1
1
11
0.6549132000  0.3265008000  1.023259000  1.374128000  1.056037000  0.8122819000  0.4277097000  1.013269000
      0.8170578000  0.83537600000  0.57209960000  1.00111300
4
W PPT Wetlands Correction
U WEL Urban Pumping
E WEL Exchange Pumping
M WEL MudLake Pumping
1
rfx ROF IESW009+IESW020+IESW055
-43560
```

Steady state stress period is 365.25 days for use with annual ET and precipitation

MDL FILE FOR SEASONAL TRANSIENT SIMULATIONS

Monthly_Null.mdl file is designed for use in 10-yr seasonal transient simulations with average monthly values in Monthly_Null.ETI and Monthly_Null.PRE files.

Adjustment factors for NIR and wetlands are from calibration run E120116A008.

```
DAYS
FEET
120 1 12
30   04/2012
31   05/2012
30   06/2012
31   07/2012
31   08/2012
30   09/2012
31   10/2012
30   11/2012
31   12/2012
31   01/2013
28.25   02/2013
31   03/2013
30   04/2013
31   05/2013
30    06/2013
.....
```

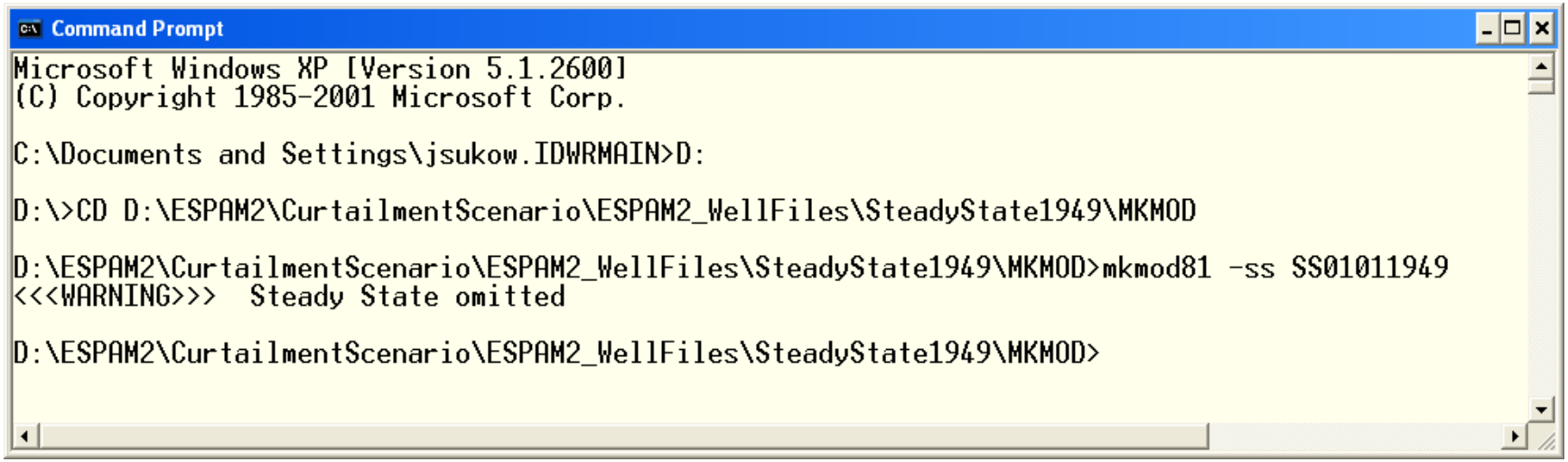
Edit number of stress periods for simulations <>10 years

Edit stress period years if desired. First stress period must be April if Monthly_Null.ETI and Monthly_Null.PRE are used.

February stress period is 28.25 days for use with average monthly ET and precipitation

Add or delete stress periods for simulations <>10 years

RUNNING MKMOD

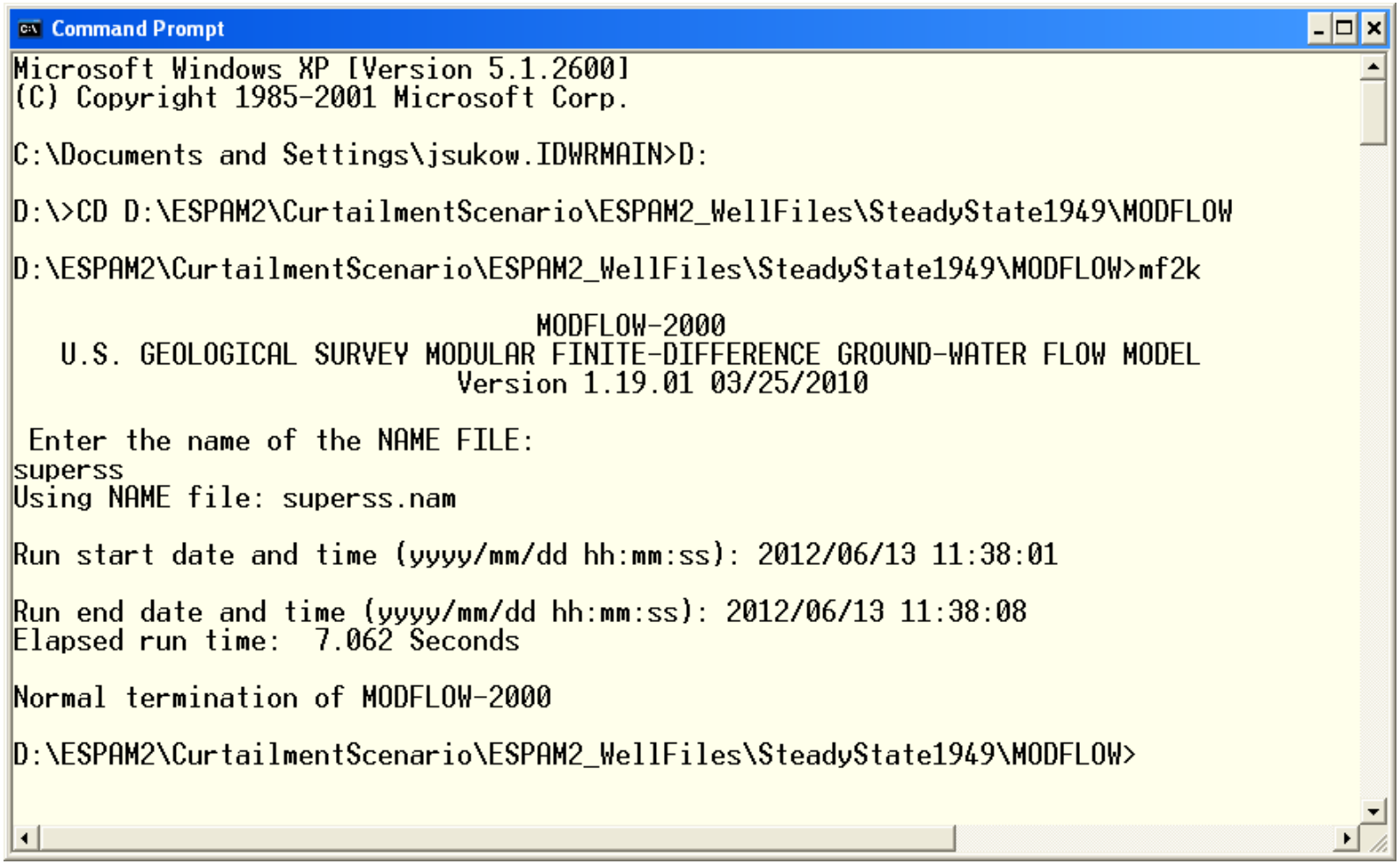


- -ss directs MKMOD to omit steady state period from well file
- *.htm file provides tables summarizing water budget
- *.net file provides net recharge in MODFLOW well file format

MODFLOW FILES FOR SUPERPOSITION

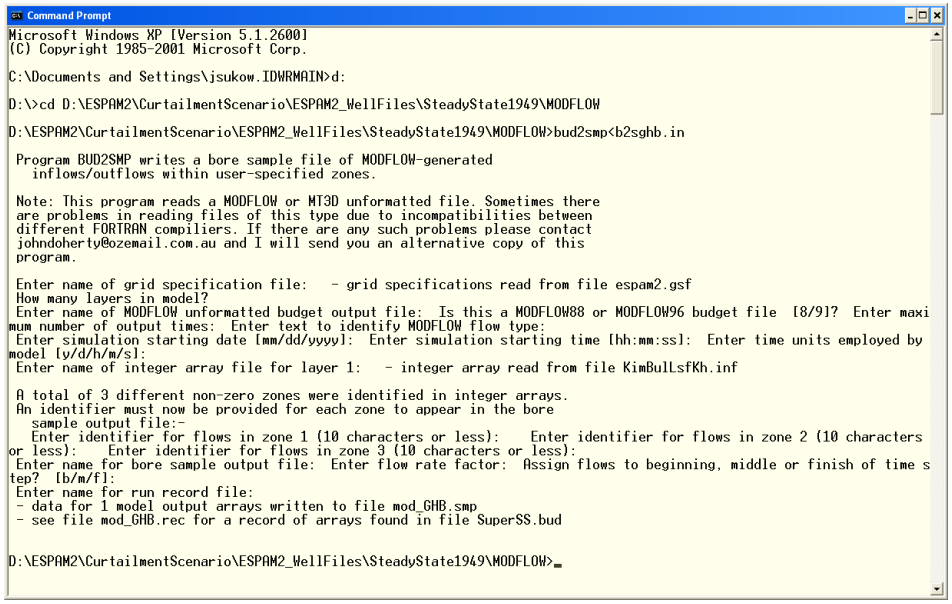
- Posted with training materials on website
- Superposition files for steady state simulations
- Superposition files for 10-yr monthly transient simulations
- Superposition files for 150-yr transient simulations with constant stress
- Add well file (MKMOD output) and edit name file

RUNNING MODFLOW



POST-PROCESSING MODFLOW OUTPUT

- LST file
- Post-processing binary budget file with BUD2SMP

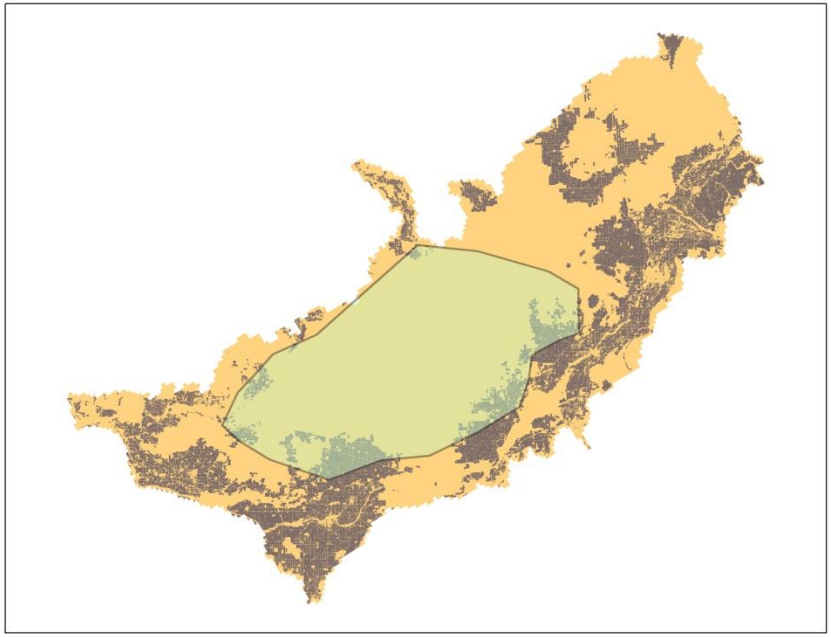


- Binary head file can be processed with MOD2SMP or MOD2OBS

BREAK

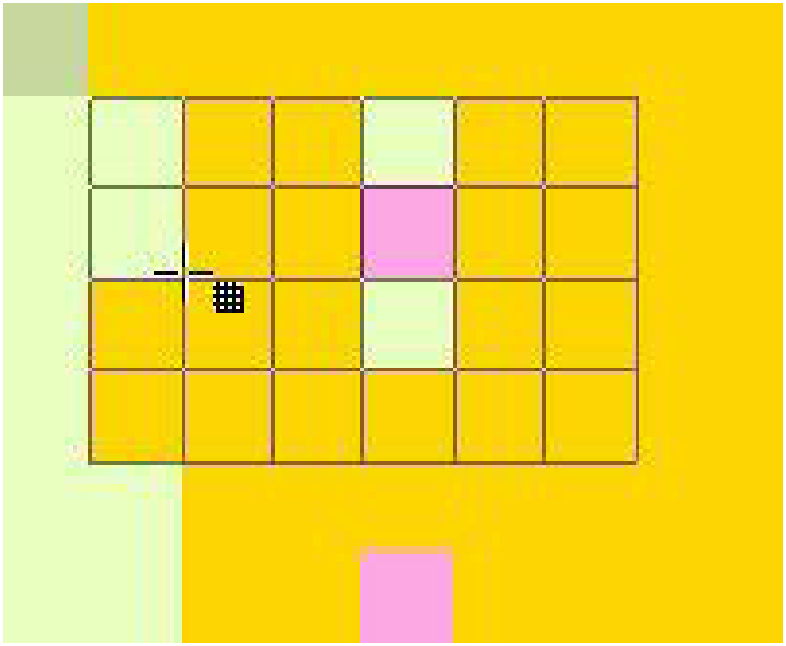
RASTER PROCESSING TIPS

- Recommendations for clipping rasters
  - Use a snap raster to maintain raster alignment
  - Clip tool in the ArcToolbox Data Management tools is preferred method
  - Extract by Mask tool may also be used, but creates a file of larger size

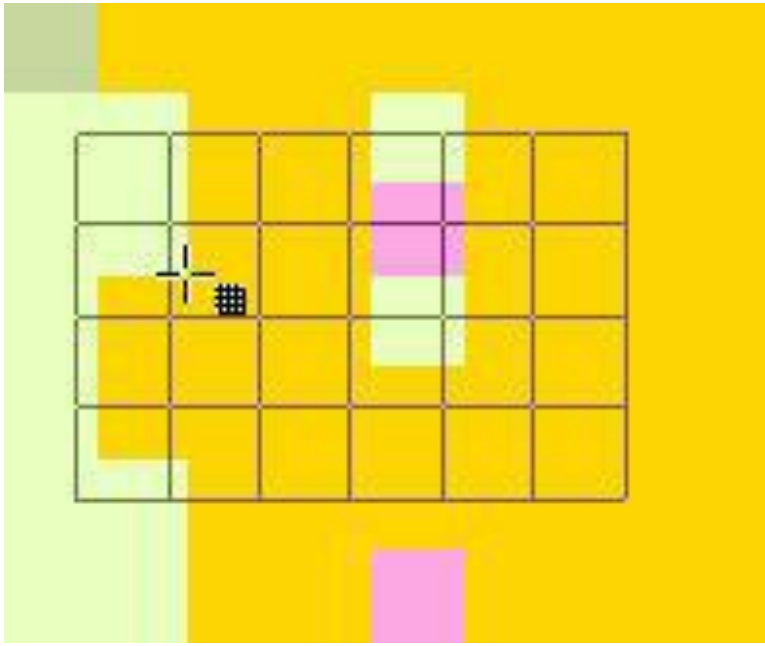


Aligning rasters to common pixel grid

Good raster alignment

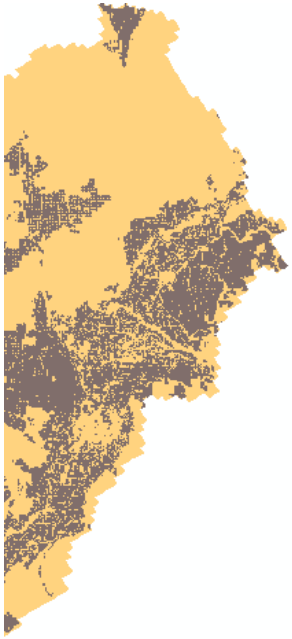


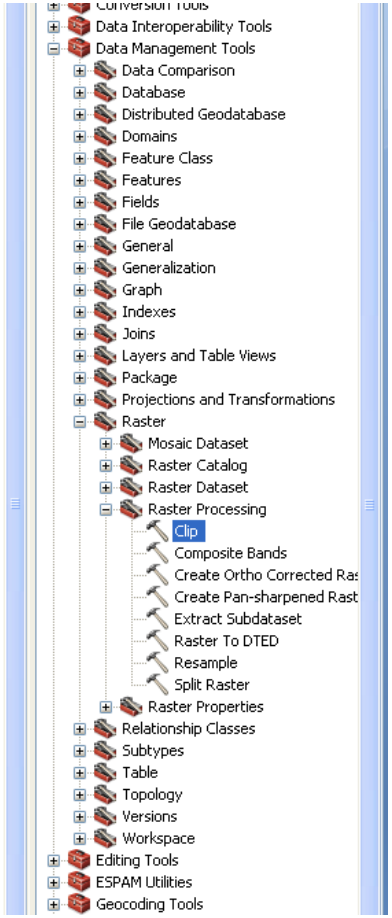
Bad raster alignment



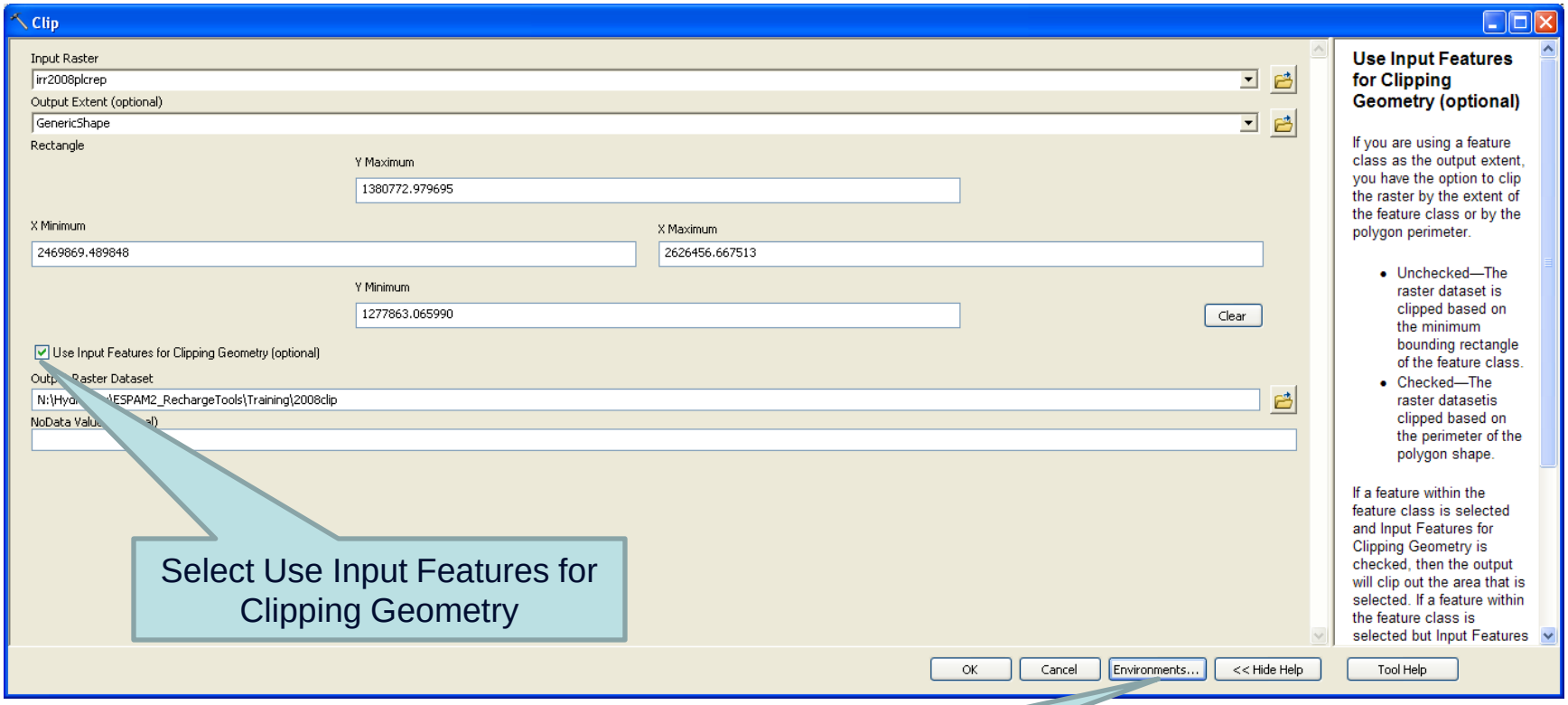
Rasters provided in NULL data are aligned to origin of (15m,15m) and have 30m x 30m pixel size

CLIPPING RASTERS

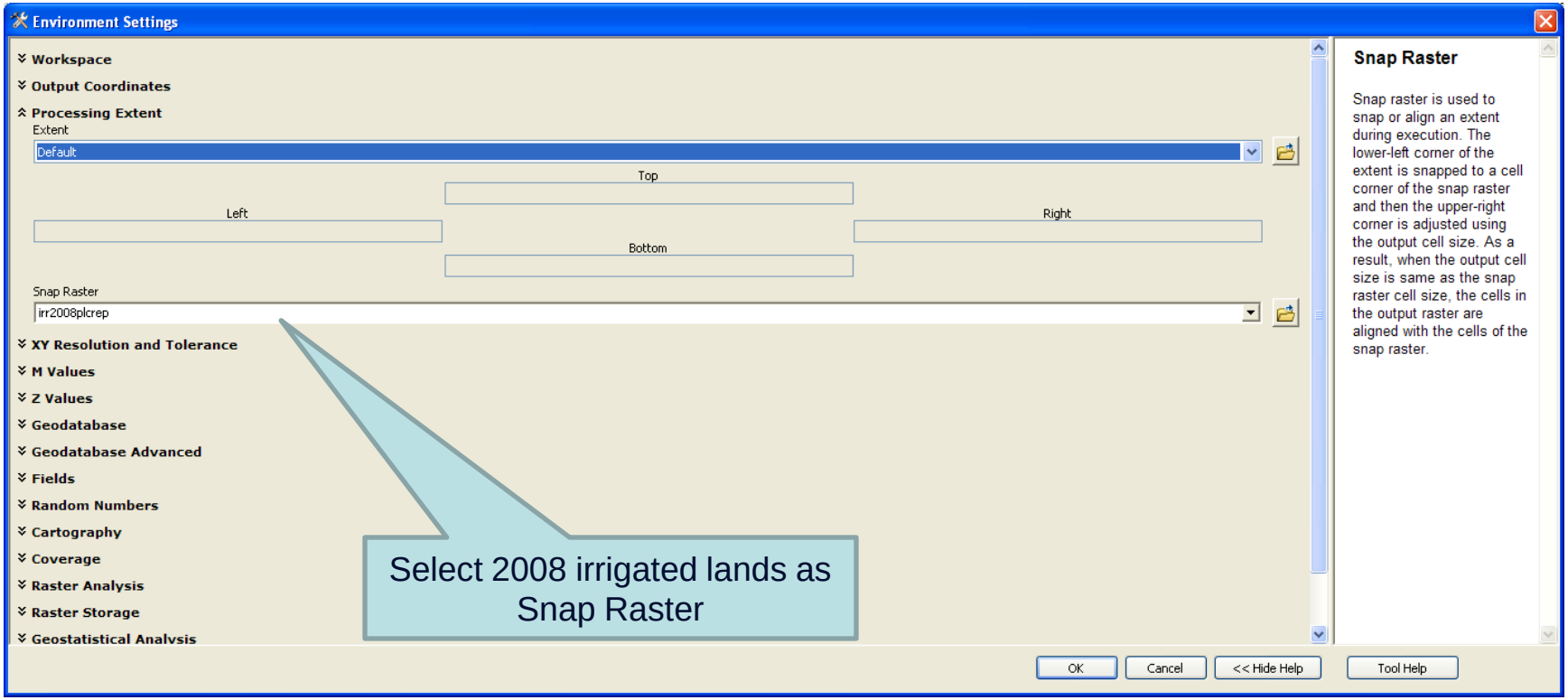




CLIPPING RASTERS



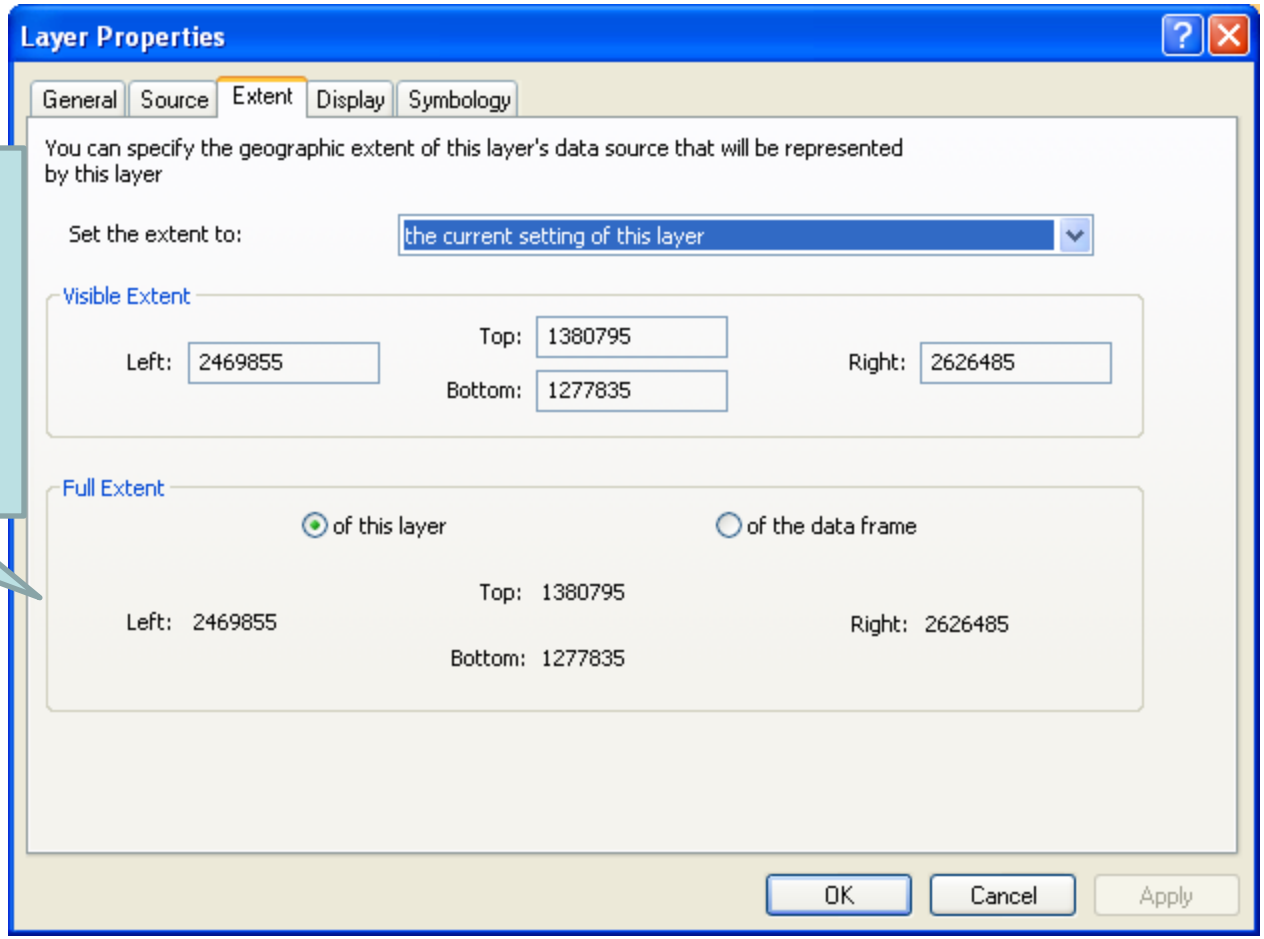
CLIPPING RASTERS



CLIPPING RASTERS

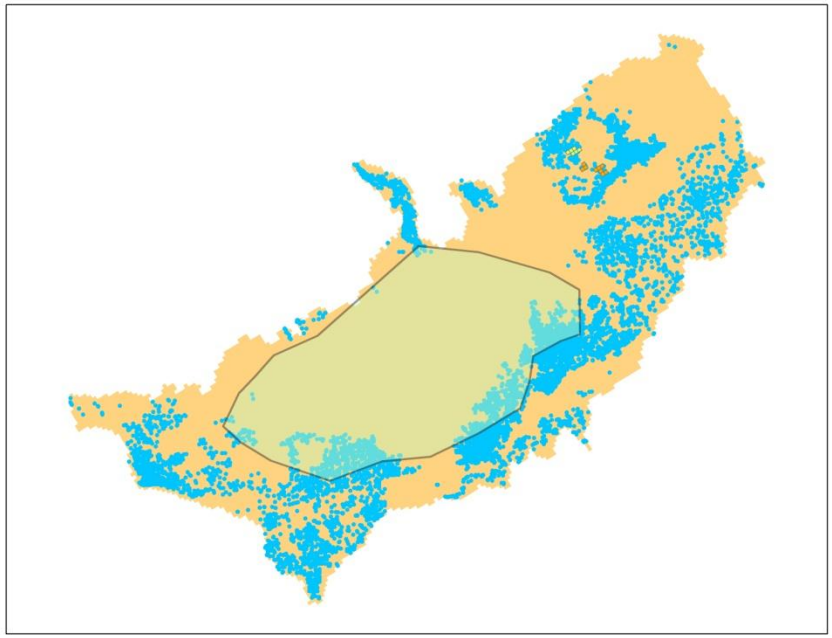
Check alignment:
Each extent value divided by 30 should have remainder of 15.

Example:
1380795/30 = 46026.5



POD FILE PROCESSING TIPS

- Recommendations for clipping rasters
  - Usually best to clip POD file to same extent as irrigated lands file, so global priority fraction reflects area of interest
  - Use caution if clip shape splits Mud Lake/Monteview area

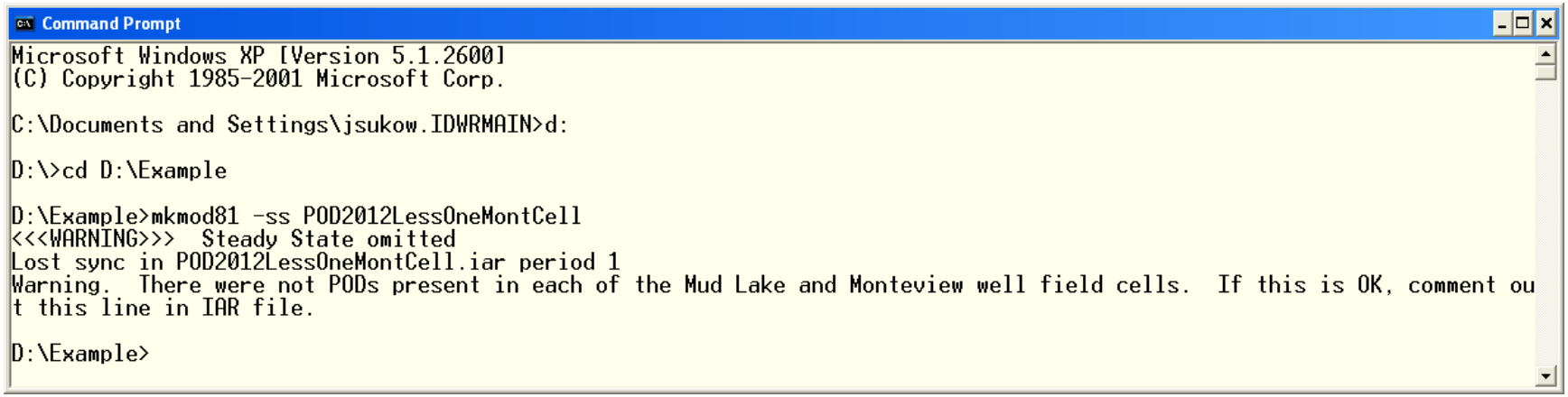


POD FILE PROCESSING TIPS

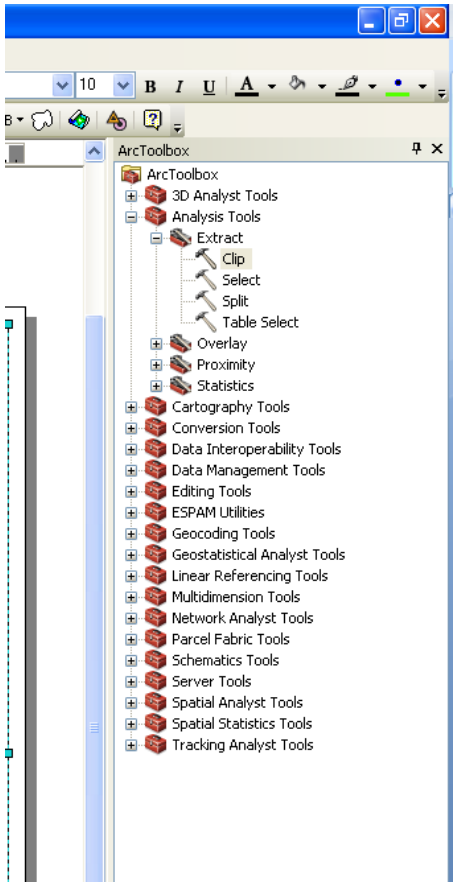
- Recommendations for clipping rasters
  - If Curtailment IAR Tool (V1.5) does not find at least one POD in each cell in the Mud Lake/Monteview well fields, it will write a warning to IAR file
  - User will need to comment out warning or make corrections to POD file as appropriate

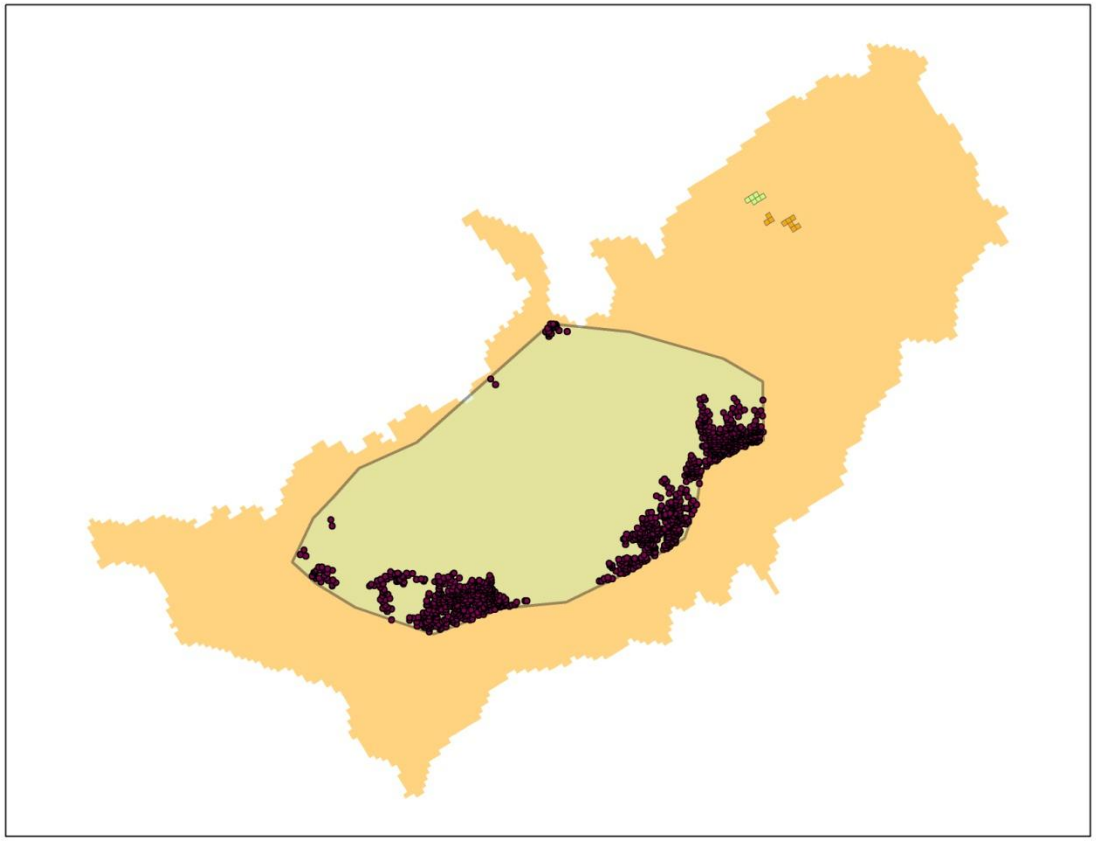
#ESPAM2_ModelGrid_06092011.shp
#sw_poly_snap
#gw_poly_snap
#wet_urb_rsmp
#avggwfrac
#2008plcrpclip
#POD2012clip.shp
Warning. There were not PODs present in each of the Mud Lake and Monteview well field cells. If this is OK, comment out this line in IAR file.
#1949-01-01
STRESS PERIOD 1
1
5337
81 128 2
IEGW506 IESW034
-13740492 0
81 129 2
…

POD FILE PROCESSING TIPS

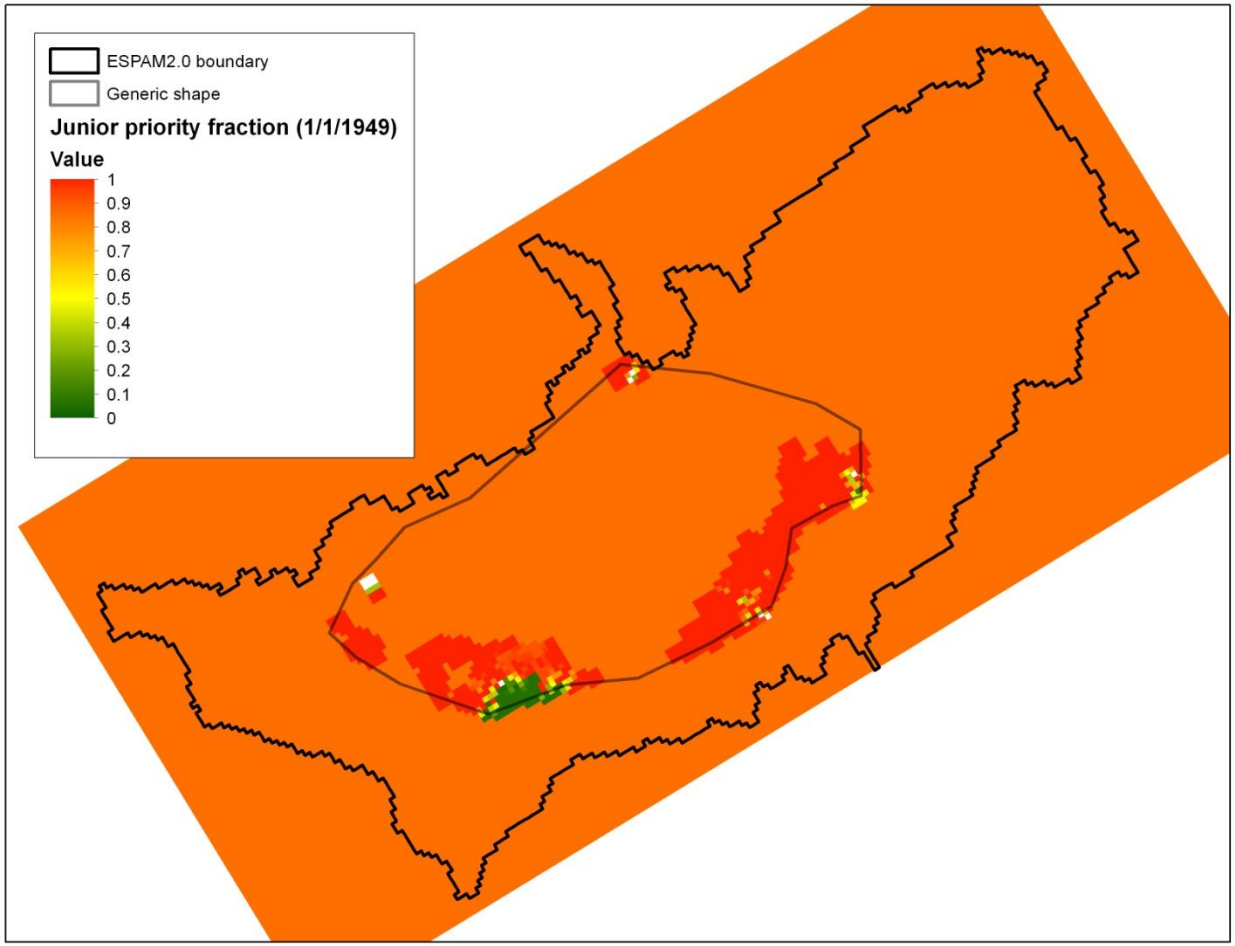


POD FILE PROCESSING TIPS





POD FILE PROCESSING TIPS



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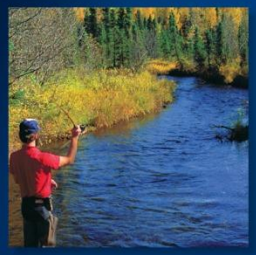

WRAP UP & QUESTIONS